

(19) World Intellectual Property Organization
International Bureau



(43) International Publication Date
8 June 2006 (08.06.2006)

PCT

(10) International Publication Number
WO 2006/059181 A1

(51) International Patent Classification:
E21B 43/04 (2006.01) *E21B 43/10* (2006.01)
E21B 43/08 (2006.01)

MG, MK, MN, MW, MX, MZ, NA, NI, NO, NZ, OM, PG, PH, PL, PT, RO, RU, SC, SD, SE, SG, SK, SL, SY, TJ, TM, TN, TR, TT, TZ, UA, UG, US, UZ, VC, VN, YU, ZA, ZM, ZW.

(21) International Application Number:
PCT/IB2004/003980

(22) International Filing Date:
3 December 2004 (03.12.2004)

(25) Filing Language: English

(26) Publication Language: English

(71) Applicant and

(72) Inventor: RESCIA, Mario [IT/SA]; Hajjan Drilling Est.,
P.O: Box 1309, 31952 Al Khobar (SA).

(84) Designated States (unless otherwise indicated, for every kind of regional protection available): ARIPO (BW, GH, GM, KE, LS, MW, MZ, NA, SD, SL, SZ, TZ, UG, ZM, ZW), Eurasian (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European (AT, BE, BG, CH, CY, CZ, DE, DK, EE, ES, FI, FR, GB, GR, HU, IE, IS, IT, LT, LU, MC, NL, PL, PT, RO, SE, SI, SK, TR), OAPI (BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW, ML, MR, NE, SN, TD, TG).

Declarations under Rule 4.17:

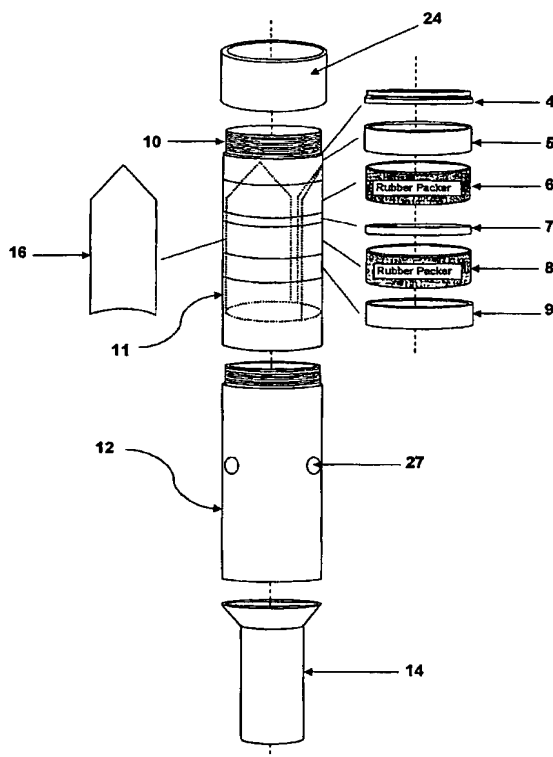
- as to the applicant's entitlement to claim the priority of the earlier application (Rule 4.17(iii))
- of inventorship (Rule 4.17(iv))

Published:

- with international search report

For two-letter codes and other abbreviations, refer to the "Guidance Notes on Codes and Abbreviations" appearing at the beginning of each regular issue of the PCT Gazette.

(54) Title: STOP-SAND LINER HANGER ASSEMBLY FOR WATER WELLS



(57) Abstract: A device for gravel packing, particularly designed for water wells, the device having a generally vertical cemented casing (1) and a stop-sand liner hanger (2), characterised in that said casing (1) comprises three elliptical balls (13) located on the inner surface of the casing (1) at the same depth level adjacent its bottom. The stop-sand liner hanger (2) comprises a gravel ports pipe (12) and a gravel setting tool guide pipe (11) around which is fixed at the top end an upper external stop-ring (4), below which are freely adjusted two rubber packers (6, 8) between a rubber packer protection ring (5) at the top and a push-up ring (9) at the bottom. The said rubber packers (6, 8) are being compressible by the push-up ring (9) resting on the three elliptical balls (13) when said push-up ring (9) is caused to slide up over the gravel setting tool guide pipe (11) against the downwards action of the weight of underlying screens/liners (15, 14). This compression increasing the external diameter of the rubber packers (6, 8) sealing off the annulus (3) between the cemented casing (1) and the stop-sand liner hanger (2).

STOP-SAND LINER HANGER ASSEMBLY FOR WATER WELLS

The present invention refers to the installation of gravel packing in water wells.

5 More particularly, this invention relates to the emplacement of gravel through a Stop-Sand Liner Hanger (SSLH) containing a simple sealing mechanism actuated by the setting of the said Stop-Sand Liner Hanger in a cemented casing, gravel ports being opened when a gravel setting tool is installed through which gravel and water are pumped down into the formation (aquifer) –
10 screens/liners annulus.

The efficiency of commercial (standard) Liner Hanger Packers used in water wells for installation of gravel packs has been often unsatisfactory due to the difficulty of a proper installation leading, in extreme cases, to the loss of the well
15 itself. The often complicated internal system to open and close gravel ports and the defective annulus sealing by rubber packers are the predominant causes for such poor efficiency. Moreover, such systems usually require the intervention of qualified engineers for their installation.

20 Gravel packing completion for water wells can become time consuming as it is never achieved in one run. In reality, the distribution of the gravel into the annulus can sometimes bridge off prematurely, leaving voids in the annulus. Usually, the gravel setting tool must be removed and put back in place one or more times before completing gravel packing, as the tools used to remove
25 these voids require a free access to the screens.

Systems capable of completing multizone gravel packing in one trip, reducing rig time by eliminating the need to run extra tools between each pumping operation, are known from the prior art. However, these systems are expensive
30 and usually aimed at oil production.

Furthermore, most of the prior art's systems require that the packers are removed from the well after completion of gravel packing leaving only a gravel screen assembly as described in US 4,733,723. A liner seal is then set for sealing engagement with the well bore for preventing migration of the gravel pack up the well annulus. This extra step, which is required by the configuration of these systems for the completion of the well, results in a loss of time.

US 4,662,446 discloses a device which does not require the removal of the gravel packers as it comprises an internal system which inflates, by fluid pressure, an elastomeric reversing boot. However, the complexity of such system implies a high production cost as well as the necessity of having highly qualified engineers for the installation and maintenance of such system.

The aim of this invention is, on the one hand, to allow an easy and trouble free installation which guarantees a stable and secure setting by eliminating the usual hold-down slips mechanism occurring with the conventional systems and, on the other hand, to reduce rig time involved with the often complicated settings and removals of the gravel setting tool while completing gravel packing.

This aim is achieved by a device such as set out in claim 1. Such device comprises a Stop-Sand Liner Hanger (SSLH) which is set inside the cemented casing by means of three elliptical balls fitted at 120 degrees from each other and at the same depth level on casing inner surface near the casing bottom. The SSLH comprises a gravel ports pipe, and a gravel setting tool guide pipe around which is fixed at the top end an upper external stop-ring, below said stop-ring are freely adjusted two rubber packers between an upper rubber packer protection ring and a push-up ring. The rubber packer is compressed as soon as the push-up ring rests on the three elliptical balls, said balls causing a relative upward movement of the push-up ring over the gravel setting tool guide pipe which tends to be dragged down by the weight of the SSLH and the underlying screens/liners. The rubber packer compression increases the packer

external diameter sealing off the annulus between the cemented casing and the SSLH.

5 The gravel ports pipe contains a simple mechanism actuated by simply lowering downwards a gravel setting tool which causes the opening of the Gravel Ports.

10 Unlike most of the systems used for gravel packing which tend to be relatively complex, the present invention does not need qualified engineers to install a gravel pack as the installation and removal of the said gravel setting tool is easy and trouble free.

15 The SSLH allows an unlimited and easy repetition of gravel emplacement operations until the gravel pack is homogeneous and complete. The removal of the gravel setting tool, after gravel packing completion, triggers the automatic closure of the gravel ports.

20 The invention will be better understood thanks to the following detailed description of a preferred embodiment with reference to the attached drawings, in which:

- Figure 1 represents, as an example, a schematic view of a completed water well with stop-sand liner hanger, gravel pack and a water pump.
- 25 - Figure 1a represents the installation of the SSLH by a liner hanger setting tool.
- Figure 1b represents a gravel packing completion operation using a gravel pack setting tool.
- 30 - Figure 1c represents a completed gravel packing.

- Figure 2 represents an exploded view of the SSLH comprising rubber packers and different rings set over the guide pipe and a gravel ports pipe.
- 5
- Figure 3 represents an elevated view of the SSLH which is about to rest on the three elliptical balls located on the internal surface of a cemented casing.
- 10
- Figure 3a represents an exploded view of the mechanism inside the gravel ports pipe.
 - Figure 4 represents an elevated view of the Gravel Setting Tool.

- 15
- Figure 1 shows a water well, after completion of gravel packing, ready for water production.

Figure 2 shows the constitutive elements of the mechanism which generates the expansion of rubber packers (6, 8) against the cylindrical cemented casing (1), thus sealing off the annulus (3) between the casing (1) and the SSLH (2) itself.

20

The mechanism comprises an upper external stop-ring (4) which is firmly kept in position by an overlying SSLH setting tool coupling (24) which is screwed on the upper threaded part (10) of the guide pipe (11), a first upper rubber packer protection ring (5), an upper rubber packer (6), an intermediate rubber packer protection ring (7), a lower rubber packer (8), and, finally, a push-up ring (9) at the bottom.

25

Three steel elliptical balls (13) are fitted with their supporting base into three casing slots (not shown) and then firmly welded on the inside and on the

30

outside of the casing before the casing (1) itself is installed and cemented. This balls-setting configuration and the balls rounded shape allow the run of a tricone rock bit or other tool.

5 The said upper, intermediate and lower (push-up ring) rings (5, 7, 9) have the same external diameter which is slightly bigger than the diameter of the upper and lower rubber packers (6, 8). While hanging the SSLH (2) on the three supporting elliptical balls (13), the push-up ring (9) slides (apparently) upwards over the guide pipe (11) as the latter is driven down by the weight of underlying
10 screens/liners (15, 14). In actual fact is the upper external stop-ring (4) that, moving downwards solidly with the SSLH main body, squeezes the upper and lower rubber packers (6, 8) trapped between the upper packer protection ring (5) and the push-up ring (9).

15 The squeezing of the upper and lower rubber packers (6, 8) causes the said rubber packers to expand, sealing off the annulus (3) between the casing (1) and the SSLH (2). The diameters of the rubber packers (6, 8) have been determined as to have a small clearance between the internal casing diameter and the rubber packers (6, 8) to ensure optimum sealing when the rubber
20 packers are expanded.

The SSLH (2) contains a gravel ports pipe (12) which comprises three ports (27), said pipe (12) is screwed to the bottom of the gravel setting tool guide pipe (11). As shown by Figure 3, the said gravel ports pipe (12) contains a spring
25 case (17), a spring (18), a gravel ports piston lower ring (19), a gravel ports piston (20), and finally a gravel ports piston upper ring (21). The positioning of the gravel setting tool (23) inside the gravel ports piston (20) compresses the spring (18) causing the downwards movement of the ports (28) of same piston (20) to the same level as the ports (27) of said gravel ports pipe (12). The inner
30 part of the gravel setting tool guide pipe (11) contains three guide plates (16) which are welded inside the pipe (11).

As shown by Figure 4, three wings (22), connected to the external diameter of the gravel setting tool (23) that contains three ports (31), slide between said guide plates (16) and guarantee that, when the gravel setting tool (23) is lowered, its ports (31) are correctly oriented to ensure perfect overlapping with the ports (28) of the piston (20). After completion of gravel packing, the gravel setting tool (23) is retrieved and the spring (18) causes the gravel ports piston (20) to regain its initial position closing the ports (27) of said gravel ports pipe (12).

A water well completion procedure using the device according to the invention can be broken down in three sequences.

1. Gravel Pack installation (Fig. 1a, 1b, 1c)
2. Development procedure
3. Pump installation for water production (Fig. 1)

Gravel packing is preceded by installing a SSLH (2) - Screen/Liners assembly (15, 14). This is achieved by means of a liner hanger setting tool (26) being fixed to the SSLH (2) by a rotational holding/release device.

The gravel setting tool (23) is then installed as aforementioned and the gravel packing process can start. Gravel and water are pumped through the workover string and the gravel ports (31). Gravel fills the screen annulus (3) and water returns to the surface by entering the screens (14) and through the lower and upper water ways (29, 30). Pressure gages are used to determine how the gravel packing progresses since the pressure inside the annulus (3) increases as the gravel packing level reaches the top of the screen (15). Pressure gages can also determine the presence of gravel bridges inside the gravel pack (25).

As mentioned earlier, gravel bridges from inside the gravel pack (25) must be removed in order to achieve a uniform and compact gravel packing. By retrieving only the gravel setting tool (23), it is possible to carry out all the necessary operations (mainly screen jetting and air lifting) to remove bridging.

- 5 As a result of the simplicity of the gravel setting tool installation and removal, these operation may easily be repeated, if needed, until gravel packing is completed, reducing significantly the rig time.

- 10 In an alternate embodiment, the SSLH (2) has only one rubber packer, having adjacently to its both sides, a push-up ring (9) and a rubber packer protection ring (5).

15

20

25

30

CLAIMS

1. A device for gravel packing, in particular for water wells, the device having a
5 generally vertical cemented casing (1) and a stop-sand liner hanger (2),
characterised in that said casing (1) comprises three bearing elliptical balls
(13) located on the inner surface of the casing (1) at the same level
adjacent its bottom, said stop-sand liner hanger (2) comprising a gravel
ports pipe (12), and a gravel setting tool guide pipe (11) around which is
10 fixed at the top end an upper external stop-ring (4) below which are freely
adjusted at least one rubber packer (6) between an upper rubber packer
protection ring (5) and a push-up ring (9), said rubber packer (6) being
compressible by the push-up ring (9) when the latter comes to rest on the
three bearing (13) which produces a relative upwards movement of the
15 push-up ring (9) over the gravel setting tool guide pipe (11) against the
downwards action of the weight of the stop-sand liner hanger (2) and
underlying screens/liners (15, 14), said compression increasing the external
diameter of the rubber packer (6) sealing off the annulus (3) between the
cemented casing (1) and the stop-sand liner hanger (2).
20
2. A device for gravel packing according to claim 1, wherein the gravel ports
pipe (12), which has three gravel ports (27), contains inside its inner
diameter a gravel ports piston (20) which is placed above a spring case
(17), said piston (20) resting on a spring (18) receives in its inside profile a
25 gravel pack setting tool (23), said spring (18) being compressed under the
weight of the gravel pack setting tool (23) when the latter is positioned
inside the SSLH (2) causing the downwards movement of the gravel ports
piston (20) and causes the opening of the gravel ports by the juxtaposition
of gravel ports (27) of the pipe (12) and ports (28) of said piston (20).
30

3. A device for gravel packing according to claim 2, wherein three guide plates (16) are fixed at angles of 120° inside the gravel setting tool guide pipe (11), said guide plates (16) axially adjust the gravel setting tool gravel ports (31) with the piston gravel ports (28).

5

4. A device for gravel packing according to claim 1, or 3, wherein the three elliptical balls (13) are located at angles of 120°.

5. A device for gravel packing according to any one of the preceding claims wherein an upper rubber packer (6) and a lower rubber packer (8) are freely adjusted around the said gravel setting tool guide pipe (11), the said upper and lower rubber packers (6, 8) being adjacent to an intermediate rubber packer protection ring (7) on one side and to respectively an upper rubber packer protection ring (5) and a push-up ring (9) on the other side.

15

20

25

30

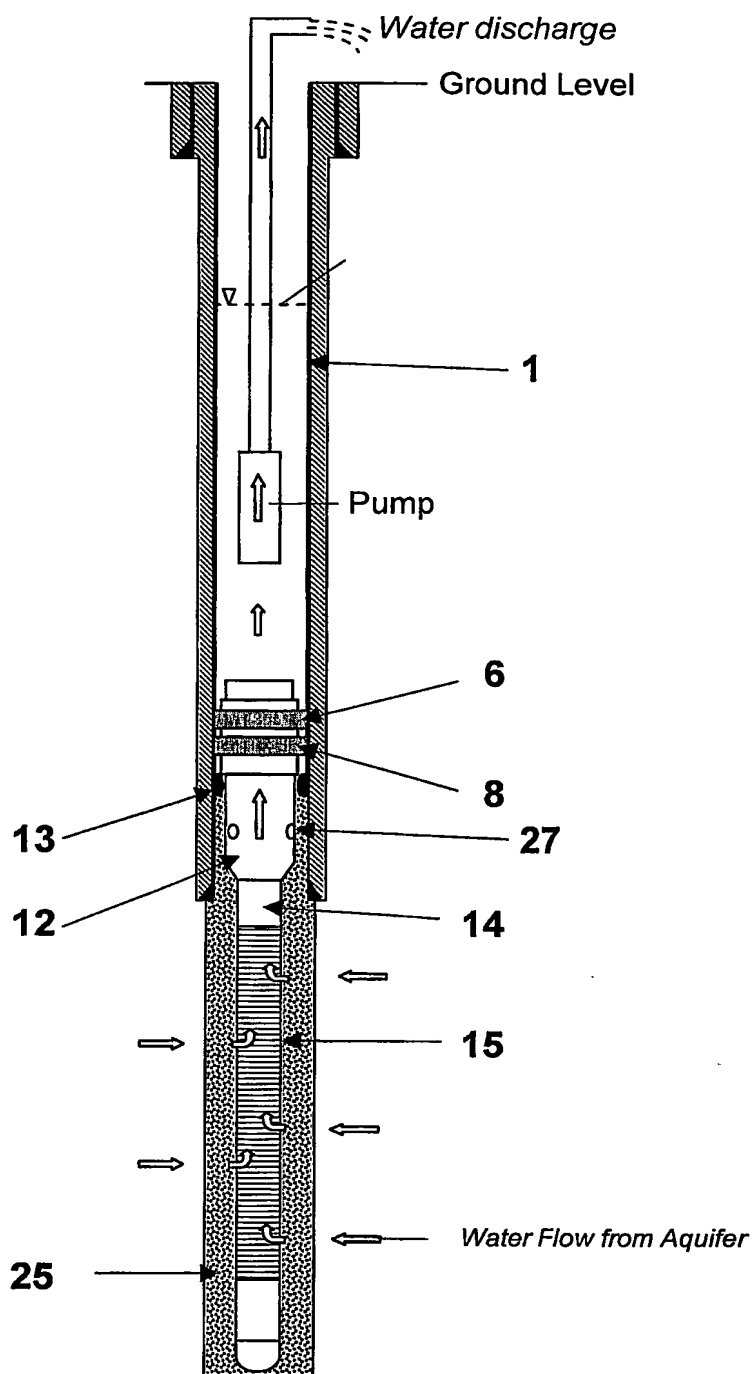


Fig. 1

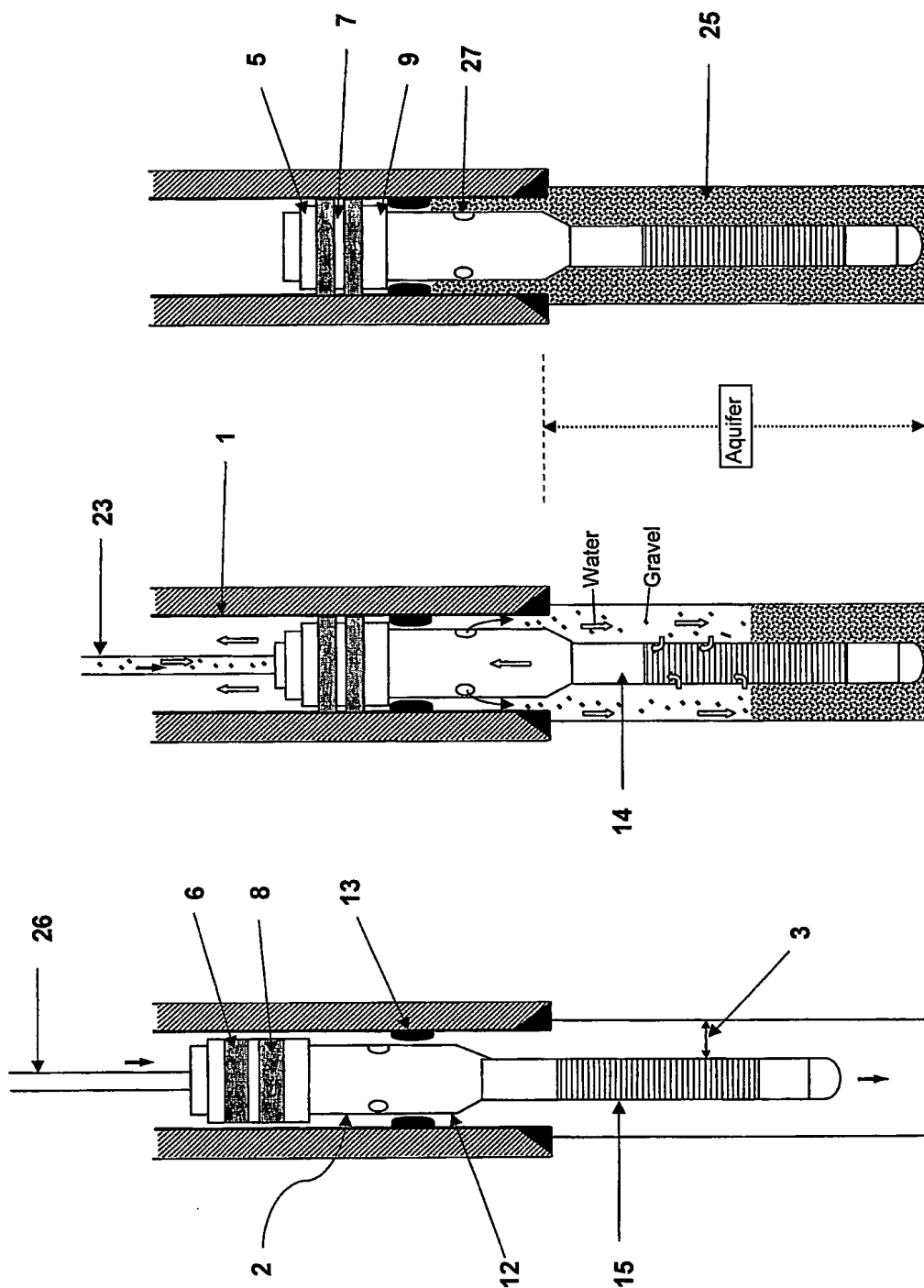
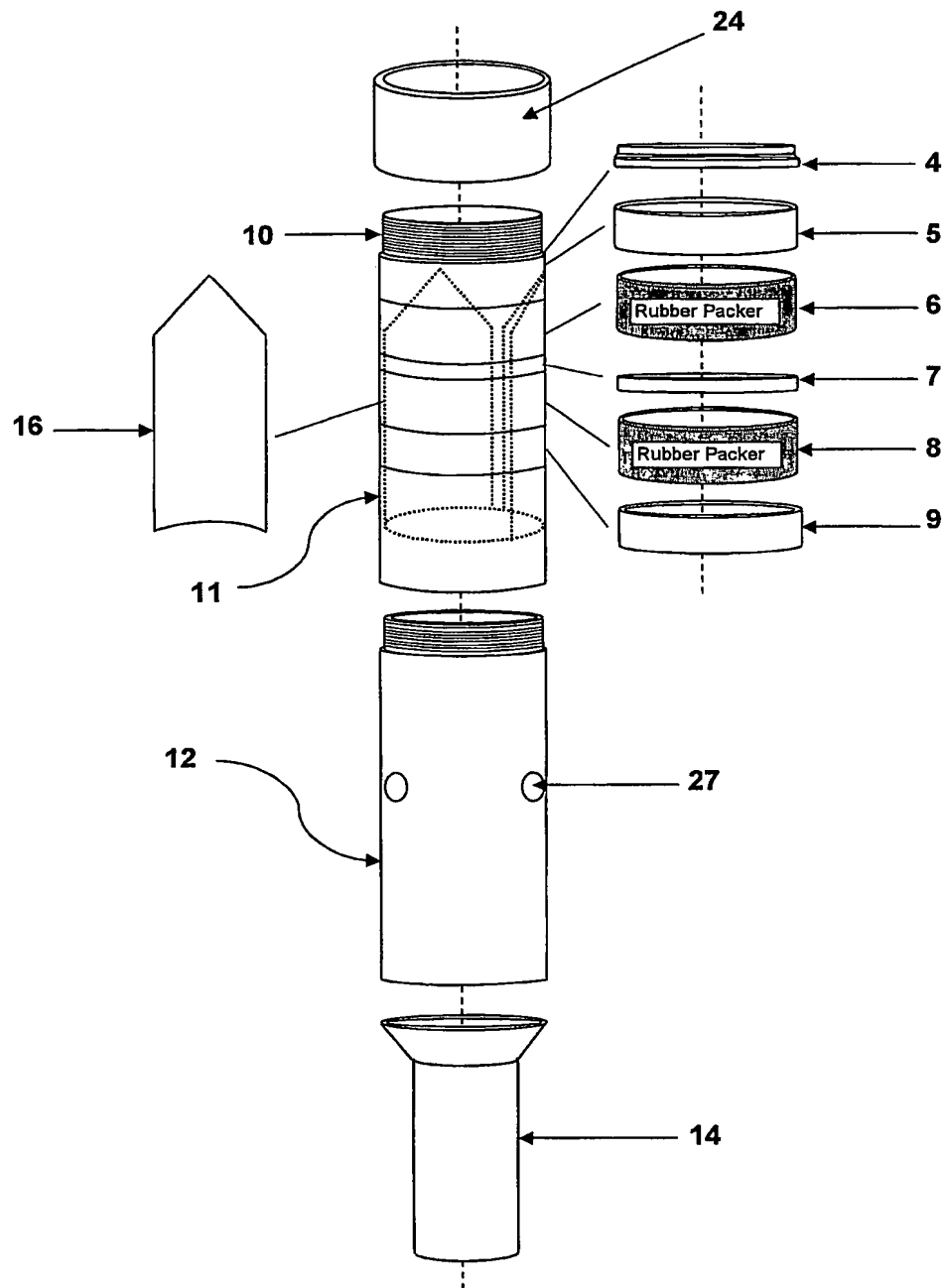


Fig. 1c

Fig. 1b

Fig. 1a

**Fig. 2**

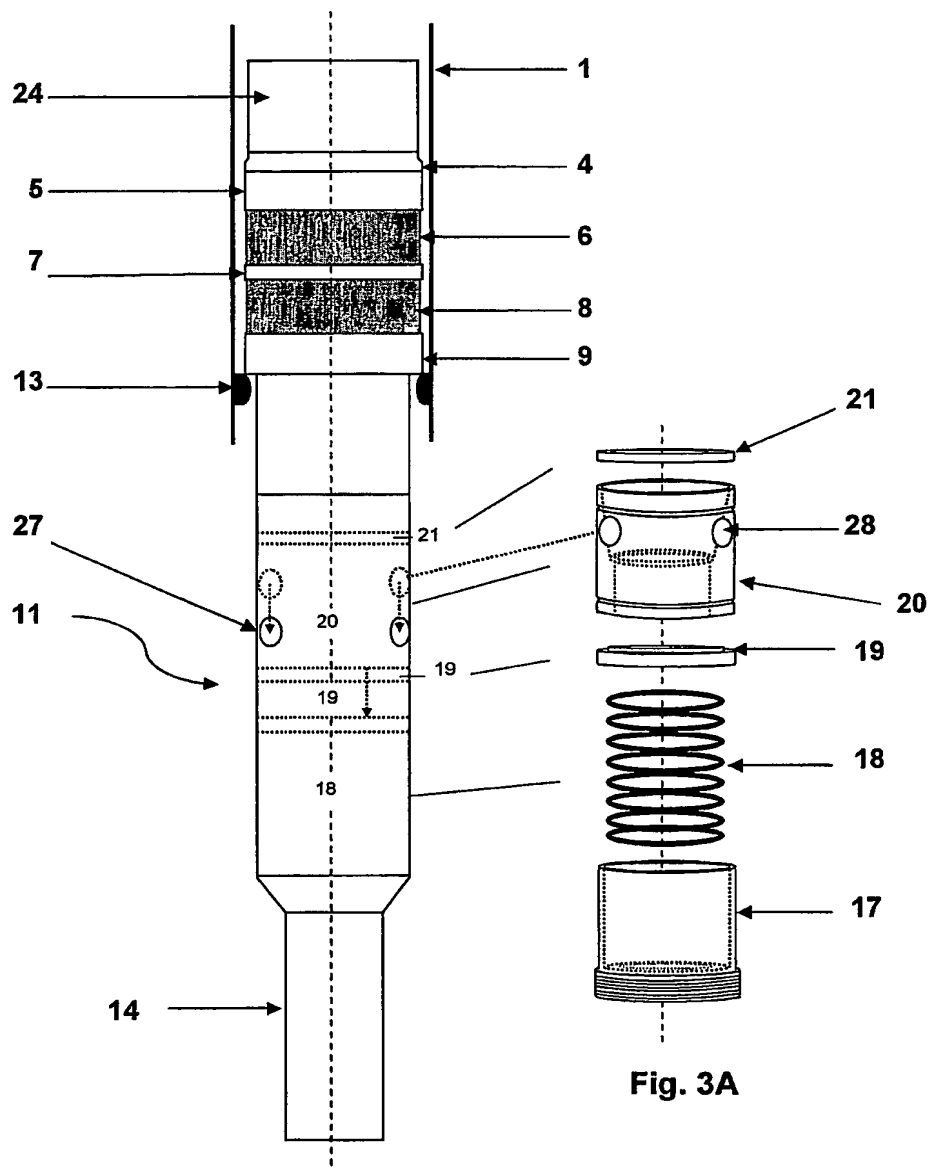
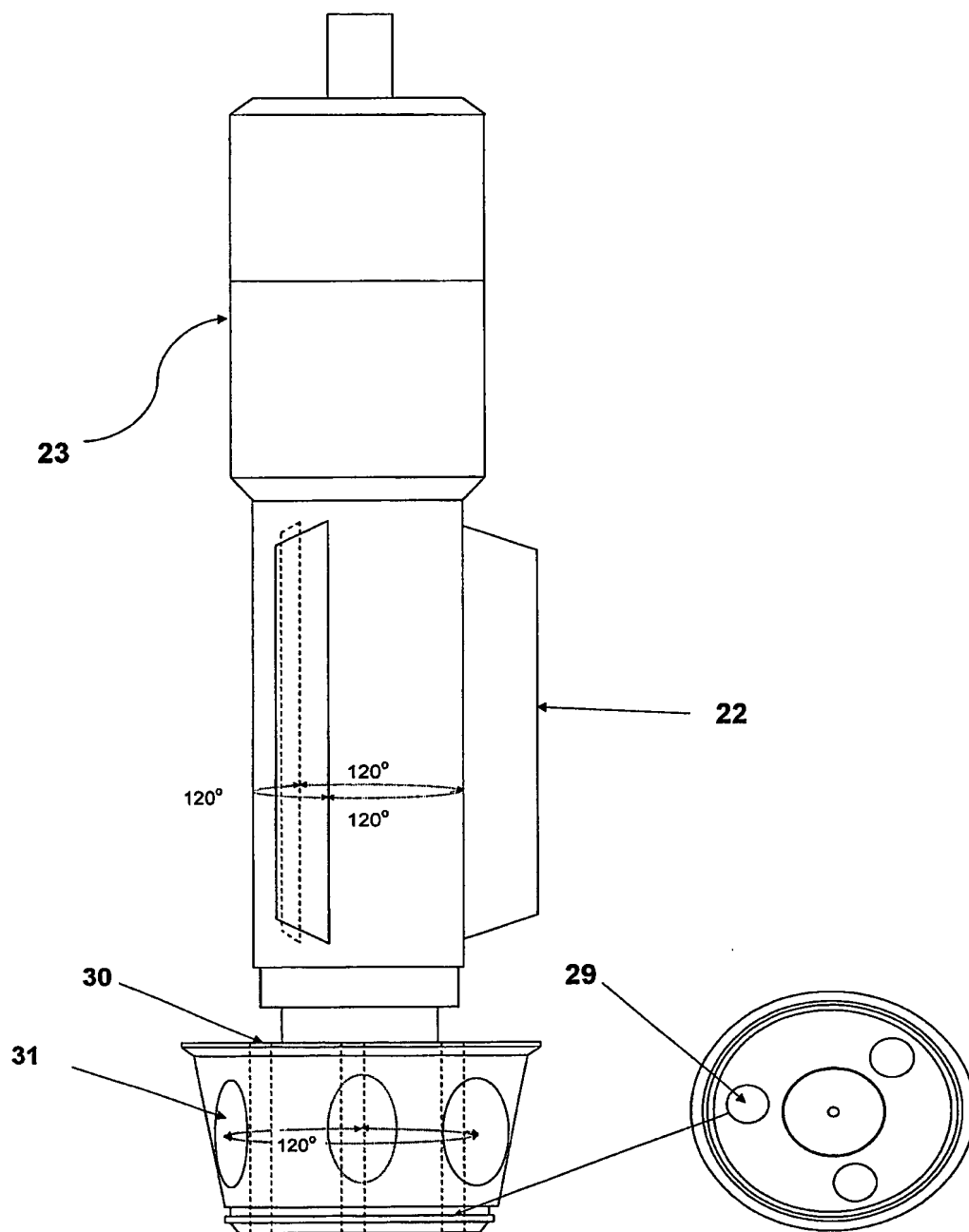


Fig. 3

Fig. 3A

**Fig. 4**

INTERNATIONAL SEARCH REPORT

Intern I Application No
PCT/IB2004/003980

A. CLASSIFICATION OF SUBJECT MATTER
IPC 7 E21B43/04 E21B43/08 E21B43/10

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC 7 E21B

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

EPO-Internal

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	US 4 662 446 A (BRISCO ET AL) 5 May 1987 (1987-05-05) the whole document	1-5
A	US 5 261 492 A (DUELL ET AL) 16 November 1993 (1993-11-16) column 7, line 26 - column 7, line 43; claim 1; figures 5-7B	1
A	US 5 358 054 A (BERT ET AL) 25 October 1994 (1994-10-25) column 3, line 57 - column 3, line 60; claim 1; figure 3	1
A	US 4 969 524 A (WHITELEY ET AL) 13 November 1990 (1990-11-13) column 2, line 50 - column 3, line 52; claim 1; figures 1A, 1B	1
-/--		

☒ Further documents are listed in the continuation of box C.

☒ Patent family members are listed in annex.

* Special categories of cited documents:

- *A* document defining the general state of the art which is not considered to be of particular relevance
- *E* earlier document but published on or after the international filing date
- *L* document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)
- *O* document referring to an oral disclosure, use, exhibition or other means
- *P* document published prior to the international filing date but later than the priority date claimed

- *T* later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
- *X* document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
- *Y* document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art.
- *Z* document member of the same patent family

Date of the actual completion of the international search

29 July 2005

Date of mailing of the international search report

11/08/2005

Name and mailing address of the ISA

European Patent Office, P.B. 5818 Patentlaan 2
NL - 2280 HV Rijswijk
Tel (+31-70) 340-2040, Tx. 31 651 epo nl,
Fax (+31-70) 340-3016

Authorized officer

Manolache, I

INTERNATIONAL SEARCH REPORT

International Application No
PCT/IB2004/003980

C.(Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	<p>US 5 857 521 A (ROSS ET AL) 12 January 1999 (1999-01-12) column 8, line 38 - column 9, line 59; figures 4-6</p>	1

INTERNATIONAL SEARCH REPORT

Information on patent family members

International Application No
PCT/IB2004/003980

Patent document cited in search report		Publication date	Patent family member(s)	Publication date
US 4662446	A	05-05-1987	NONE	
US 5261492	A	16-11-1993	NONE	
US 5358054	A	25-10-1994	CA 2118969 A1	29-01-1995
US 4969524	A	13-11-1990	BR 9004678 A GB 2237047 A , B	10-09-1991 24-04-1991
US 5857521	A	12-01-1999	US 5762137 A EP 0805259 A2 NO 971921 A	09-06-1998 05-11-1997 30-10-1997